PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in and relating to Compression Distillation Plant

We, THE ENGLISH ELECTRIC COMPANY LIMITED, a British Company, of Queens House, 28, Kingsway, London, W.C.2, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to compression distillation for example as carried out in a plant for the distillation of sea water by the use of the waste heat of a thermal power plant such as internal combustion piston-engine, gas turbine power plant or a steam power piston engine or turbine plant for the propulsion of a ship.

According to the invention the raw water is first brought into direct contact with super-heated steam in a preheater wherein a considerable proportion of the scale forming constituents is precipitated: the precipitated scale-forming constituents are withdrawn from the preheated water, and the brine, thus heated and slightly diluted by the condensed steam, is passed to an evaporator where it enters into direct heat exchange with its own vapour drawn from it and compressed by a compressor, and passed through a heating coil embedded in the brine: the distillate condensed in the coil by this indirect heat exchange is passed through a pressure reducing means into a liquid-vapour separator from where the separated water is drawn off to storage or to consumers while the steam flashed off owing to reduction of pressure is pumped away and then super-heated, for example by means of waste heat from a thermal power plant, and recycled into the preheater to the raw water.

Scale-forming sludge and concentrated brine are blown down continuously or intermittently from the preheater and from the evaporator, respectively, but the total blow down can be smaller than required in distillation plant without separate preheater and evaporator.

In order that the invention may be better understood and readily carried into effect, an embodiment of a compression distillation plant according to the invention and its manner of operation will now be described by way of example with reference to the diagrammatic drawing accompanying the Provisional Specification:—

Raw water, say sea water, is fed through a pipe 1, controlled by a valve 2, and through a spray 3 into a preheater 4, into which super-heated steam is blown through nozzles 5. Scale-forming material is precipitated in the preheater 4 as a sludge, drawn off through a pipe 6 and blown down by a pump 7. The liquid freed from the precipitated material will now be referred to as brine.

Hot brine, substantially freed from scale-forming matter and slightly diluted by the steam condensed in it, is passed from the preheater 4 through a pipe 8 to an evaporator 9, from the top of which steam is drawn off and compressed by a compressor 10 and passed through a coil 11 immersed in the brine in the evaporator. The energy imparted to the steam by the compressor 10 is given off by heat exchange to the brine, whereby the latter evaporates, while a corresponding proportion of steam condenses in the coil 11 and is drawn off through a pipe 12.

Concentrated brine is blown down through a pipe 13 by a pump 14.

The condensate from pipe 12, or the greater part of it, is throttled down to reduced pressure by a valve 15 and is discharged into a separator 16 from the bot-

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tom of which distilled water is drawn off through a pipe 17 and pumped to storage or to a consumer by a pump 18.

Owing to the reduced pressure in the separator 16 a proportion of the condensate evaporates. This steam is drawn off from the top through a pipe 19 by a steam compressor 20 which raises its pressure to that required for blowing the super-heated steam into the preheater 4 through the nozzles 5. Super-heating is effected in a super-heater 21 in heat exchange with the hot gases or vapours in the exhaust duct 22, from a thermal power plant.

A by-pass 23, controlled by a valve 24, may be branched off from pipe 12 which passes part of the condensate at a pressure which is slightly below that in pipe 12 and substantially equal to that in the discharge from the steam compressor 20, through a heat exchanger 25 the hot pass of which is preferably in series with that of super-heater 21 and the steam evolved from this part of the condensate is mixed with that discharged from the steam compressor 20. The mixture of steam is then super-heated in the super-heater 21 as described.

For distillation plant operating in conjunction with steam power plant, the steam compressor 20 and the super-heater 21 may be replaced by a steam ejector for maintaining low pressure conditions in the separator 16. The by-pass 23, the valve 24 and the heat exchanger 25 will then also be dispensed with.

In the embodiment described the separator and the heat transfer surfaces used for the evaporation are kept substantially free from scale, without requiring any chemical treatment of the raw water, whereby higher thermal efficiency and longer working periods can be obtained than with surfaces exposed to the deposition of scale.

This prevention of any substantial scale formation on the heat exchanging surfaces prevents a reduction of rate of evaporation and a rise of pressure across the compressor which might otherwise bring its operative conditions within the range of surging of a turbo-compressor. The arrangement according to the present embodiment allows therefore the use of an axial or centrifugal flow compressor which in view of the large volumes of vapour to be compressed is superior to any volumetric compressor of a rotary or reciprocating type.

What we claim is:—

1. A compression distillation process comprising the steps of bringing raw water into direct contact with super-heated steam whereby a considerable proportion of the scale-forming constituents is precipitated; eliminating the precipitated constituents from the brine, passing the brine thus preheated and slightly diluted by condensed steam into an evaporator wherein it is evaporated by indirect heat exchange with its own vapour drawn off from it and compressed by the supply of outside energy; drawing-off concentrated brine from the evaporator and condensate from the heat exchanger; relieving the condensate from pressure and separating the steam formed thereby; recompressing and super-heating the separated steam and recycling it into direct contact with raw water.

2. A compression distillation plant which comprises a preheater having nozzles for blowing super-heated steam into raw water contained in its liquid space and blow-off means for the scale-forming material precipitated by the said super-heated steam; an evaporator having its liquid space connected with the liquid space of the said preheater and its vapour space connected through a steam compressor with a heat exchanger pass through its own liquid space, blow-off means being provided for the brine concentrating in said evaporator; a liquid-vapour separator, connected through pressure reducing means with the effluent end of said heat exchanger pass, having its liquid space connected with discharge means for the condensate and having its vapour space connected with pressure raising means; and a vapour heating means having its inlet connected with the effluent end of said heat exchanger pass at least partly through the said pressure raising means, said separator and said pressure reducing means, and having its outlet connected with the said nozzles in the preheater.

3. A compression distillation plant as claimed in claim 2 wherein the steam compressor connected between the steam space of the evaporator and the heat exchanger pass through its liquid space is a turbo-compressor.

4. A compression distillation plant as claimed in claim 2 wherein the vapour heating means is a super-heater heated by waste heat from a thermal power plant.

5. A compression distillation plant as claimed in any of the claims 2 to 4 wherein a by-pass from up-stream of the pressure reducing means to the nozzles in the preheater is arranged through a super-heater heated by waste heat from a thermal power plant.

6. A compression distillation plant as claimed in claims 4 and 5 wherein the hot pass of the super-heater for the by-passed

condensate is arranged in series with the hot pass of the super-heater for the compressed vapours from the separator, and the cold pass of the super-heater for the by-passed condensate issues into the entrance of the cold pass of the super-heater for the compressed vapours from the separator.

7. A compression distillation plant as claimed in claim 2 wherein the pressure raising means and vapour heating means are combined in a steam ejector.

8. A compression distillation process as claimed in claim 1 wherein part of the vapour, substantially condensed in the heat exchanger pass through the evaporator, is branched off with comparatively small reduction of pressure before relieving the rest of the condensate from pressure, and is vaporized separately and subsequently recombined with the recompressed vapours evolved from the rest of the condensate, the combined vapours being super-heated together before being recycled into direct contact with the raw water.

9. A compression distillation process as claimed in claim 1 wherein the vapours evolved from the condensate after its being relieved from pressure are simultaneously recompressed and super-heated by ejector action of steam.

10. A compression distillation plant as claimed in claim 2 substantially as described with reference to the drawing accompanying the Provisional Specification.

11. A compression distillation process as claimed in Claim 1 or claim 8 substantially as described with reference to the drawing accompanying the Provisional Specification.

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PROVISIONAL SPECIFICATION

Improvements in and relating to Compression Distillation Plant

We, THE ENGLISH ELECTRIC COMPANY LIMITED, a British Company, of Queens House, 28, Kingsway, London, W.C.2, do hereby declare the nature of this invention to be as follows:—

The invention relates to compression distillation plant in general, and without prejudice to this broad applicability, more particularly to a plant for the distillation of sea water by the use of the waste heat of a thermal power plant such as an internal combustion piston-engine or turbine power plant or a steam power plant for the propulsion of a ship.

It is an object of the invention to provide a compression distillation plant and a method for its operation which keeps the heat transfer surfaces used for the evaporation substantially free from scale without requiring any chemical treatment of the raw water.

According to an important feature of the invention the raw water is first brought into direct contact with superheated steam in a preheater wherein a considerable proportion of the scale-forming constituents is precipitated; the brine, thus heated and slightly diluted by the condensed steam, is passed to an evaporator where it enters into indirect heat exchange with its own vapour drawn from it and compressed by a compressor, and passed through a heating coil embedded in the brine; the condensed distillate from this coil is passed through a throttle valve into a separator from where its greater part is drawn off to storage or to consumers while the steam flashed off owing to reduction of pressure is pumped away and then superheated by means of waste heat from the thermal power plant and recycled into the preheater to the raw water.

Scale-forming sludge and concentrated brine are blown down continuously or intermittently from the preheater and from the evaporator, respectively, but the total blow down can be smaller than required in distillation plant without separate preheater and evaporator.

The separator and the heat exchanging surfaces in the evaporator keep substantially free from scale whereby higher thermal efficiency and longer working periods can be obtained than with surfaces exposed to the deposition of scale.

In order that the nature of the invention be better understood, an embodiment of a compression distillation plant according to the invention and its manner of operation will now be described by way of example with reference to the accompanying diagrammatic drawing.

Raw water, say sea water, is fed through pipe 1, controlled by valve 2, and a spray 3 into the preheater 4, where superheated steam is blown in through the nozzles 5. Scale-forming material is precipitated in the preheater 4 as a sludge and drawn off through pipe 6 and blown down by a pump 7.

Hot brine, substantially freed from scale-forming matter, is passed from the preheater 4 through pipe 8 to the evaporator 9, from the top of which vapour is drawn off and compressed by a compressor 10 and passed through a coil 11 immersed in the brine in the evaporator. The energy imparted to the vapour by the compressor 10 is given off by heat exchange to the brine, whereby the latter evaporates, while a corresponding proportion of vapour condenses in the coil 11 and is drawn off through pipe 12.

Concentrated brine is blown down through pipe 13 by pump 14.

The condensate from pipe 12, or the greater part of it, is throttled down to reduced pressure by valve 15 and discharged into the separator 16 from the bottom of which it is drawn off through pipe 17 and pumped to storage or a consumer by pump 18.

Owing to the reduced pressure in the separator 16 a proportion of the condensate evaporates. This vapour is drawn off from the top through pipe 19 by a steam pump 20 which raises its pressure to that required for blowing the superheated steam into the preheater 4 through the nozzles 5. Superheating is effected in the superheater 21 in heat exchange with the exhaust 22 from the thermal power plant.

A by-pass 23, controlled by valve 24, may be branched off from pipe 12 which passes part of the condensate at a pressure slightly below that in pipe 12 and substantially equal to that in the discharge from compressor 20 through a heat exchanger 25 the hot pass of which is preferably in series with that of superheater 21 while the steam evolved from this part of the condensate mixes with that discharged from compressor 20. The mixture of steam is then super-heated in the superheater 21 as described.

For distillation plant operating in conjunction with steam power plant, the steam pump 20 and the superheater 21 may be replaced by a steam ejector for maintaining low pressure conditions in the separator 16. The by-pass 23, valve 24 and heat exchanger 25 will then also be dispensed with.

The prevention of any substantial scale formation on the heat exchanging surfaces prevents the reduction of rate of evaporation and rise of pressure across the compressor which might otherwise bring its operative conditions within the range of surging of a turbo-compressor. The arrangement according to the present invention allows therefore the use of an axial or centrifugal flow compressor which in view of the large volumes of vapour to be compressed is superior to any volumetric compressor of a rotary or reciprocating type.

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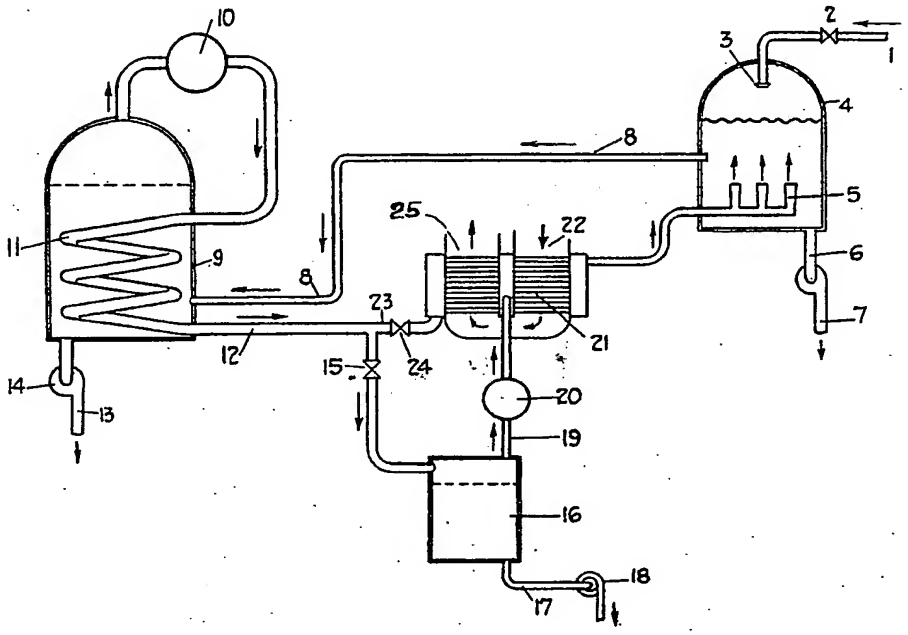

H.M.S.O. (M.F.P.)